DOCUMENT RESUME

ED 252 418 SE 045 340

AUTHOR Richwine, Reynold D.
TITLE Trickling Filters. Student Manual. Biological Treatment Process Control.
INSTITUTION Linn-Benton Community Coll., Albany, Oreg.
SPONS AGENCY Environmental Protection Agency, Washington, D. C.
PUB DATE 84
GRANT EPA-T901238
NOTE 26p.; For related documents, see SE 045 333-354.
AVAILABLE FROM Linn-Benton Community College, 6500 S.W. Pacific Blvd., Albany, OR 97321.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Biology; Laboratory Procedures; Microbiology; Post Secondary Education; *Sludge; *Training Methods; *Waste Disposal; *Waste Water; *Water Treatment
IDENTIFIERS *Trickling Filters; Unit Processes

ABSTRACT

The textual material for a unit on trickling filters is presented in this student manual. Topic areas discussed include: (1) trickling filter process components (preliminary treatment, media, underdrain system, distribution system, ventilation, and secondary clarifier); (2) operational modes (standard rate filters, high rate filters, roughing filters, filter staging); (3) trickling filter microbiology (biomass, nutritional requirements, metabolism rates, growth and sloughing cycle); (4) trickling filter process monitoring, including the use of laboratory data to aid in plant operations; and (5) operational problems and solutions (focusing on filter flies, high effluent suspended solids, high hydraulic loading rates, icing, in-plant recycle streams, low temperature wastewaters, odors, orifice plugging, ponding, reduction in biological oxidation demand (BOD) removal, and toxic loadings). A list of unit objectives, glossary of key terms, aand student worksheet are included. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Biological Treatment Process Control

ED252418

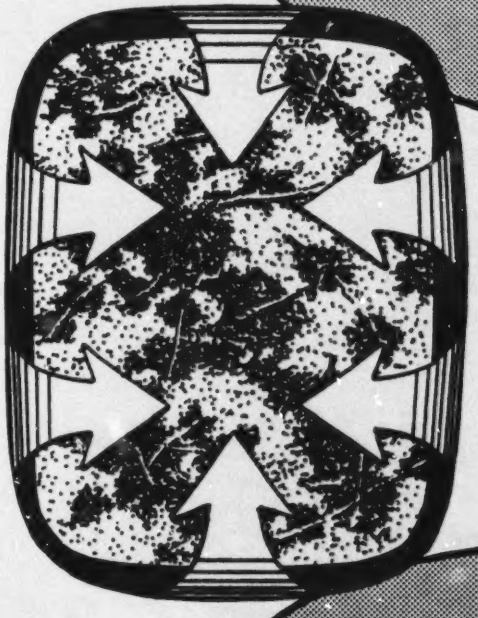
U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Trickling Filters



"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

John W. Carnegie

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE 045 340

Linn-Benton Community College
Albany, Oregon

1984

BIOLOGICAL TREATMENT PROCESS CONTROL

TRICKLING FILTERS

STUDENT MANUAL

Text Written By:
Reynold D. Richwine
CH2M-Hill, Inc.
Portland, Oregon

Edited By:
John W. Carnegie, Ph.D.
Project Director
Linn-Benton Community College
Albany, Oregon

Instructional Design:
Priscilla Hardin, Ph.D.
Priscilla Hardin Instructional Services
Corvallis, Oregon

Developed Under:
EPA Grant #T901238
1984

TRICKLING FILTERS

STUDENT MANUAL

Table of Contents

	Page
Objectives	TF-1
Glossary	TF-2
Text	
Introduction	TF-3
Components	TF-3
Operational Modes	TF-5
Trickling Filter Microbiology	TF-6
Trickling Filter Process Monitoring	TF-8
Operational Problems & Solutions	TF-14
References	TF-20
Worksheet	TF-21

TRICKLING FILTERS

Objectives

Upon completion of this lesson, you should be able to do the following:

1. Describe the six components necessary in the trickling filter process.
2. Identify the three operational modes when given their characteristics.
3. Recall what is meant by filter staging.
4. Recall the types of organisms found in a trickling filter.
5. Recall the nutritional requirements of filter biomass.
6. Describe the two factors which effect the rate of metabolism.
7. Briefly state the biomass growth cycle in a filter.
8. List five operational control tests which should be done by the operator.
9. Calculate: recirculation ratio, hydraulic loading, organic (BOD) loading, process efficiency.
10. Describe how trend charts are used in daily operations.
11. Give remedies for typical operational problems.

Glossary

Attached growth - A biological treatment system in which the microbial mass is attached to a stationary surface (such as rocks, wood or plastics), and the nutrients and air are circulated past the growing biomass.

Icing - The buildup of ice on distribution arms and nozzles and the surface of the media.

Media - The surface to which the microbial mass is attached (rock, wood or plastics) in an attached growth system.

Ponding - Accumulation of liquid in a pool on the media surface; the result of clogged media.

Recirculation - Returning flow to the start of a process for re-treatment; in trickling filters, returning filter effluent for a second pass through the filter.

Roughing filters - Heavily loaded trickling filters designed to reduce the organic loading on subsequent treatment processes. Loads greater than 115 lbs BOD/day/1,000 ft^3.

Sloughing (sloughed biomass) - The act of losing or the material lost from the media as the biomass on a specific area becomes too heavy to stay attached.

Underdrain system - The system of drains, tiles, and channels designed to collect the liquid after it has passed down through the media and to distribute the flow of oxygen-containing air to all parts of the filter for upward draft through the media.

TRICKLING FILTERS

INTRODUCTION

A trickling filter is an attached growth biological secondary treatment process with stationary media. The process converts dissolved and suspended organics (BOD) in the waste stream into a stable, settleable biomass. This biomass is removed from the waste stream by a secondary clarifier, leaving a plant effluent low in BOD and suspended solids.

TRICKLING FILTER PROCESS COMPONENTS

There are six required components to every trickling filter process.

Preliminary treatment of the waste stream is required to lower BOD loadings and prevent media and orifice clogging. Primary sedimentation will remove settleable and floatable solids and lower the BOD loading on the process. Screening and grinding lessens the chance of having large solids plug the media and distribution system.

The media provides surface area upon which the biological growth attaches itself. The most common media used is rock. Other media used include redwood or Douglas fir slat pallets, synthetics, random-dumped plastic, or stacked plastic bundles. The object of the media is to supply a large surface area for the biomass to attach itself and enough void space so the air and the waste stream can easily pass through the filter.

The underdrain system supports the media, allows airflow, and collects the waste stream. For rock media, the underdrain system is usually made with prefabricated porous blocks made of concrete or vitrified clay. Other medias may use the same type of system or one designed specifically for that media.

The distribution system evenly distributes the waste stream over the surface of the media. The distribution system can be either rotary, for round filters, or fixed nozzle, for rectangular filters.

A rotary-type consists of two or more horizontal pipes supported above the media by the inlet piping at the center of the filter. As the wastewater flows from the nozzles on the side of the pipes, the pipe network rotates which evenly distributes the wastewater over the surface of the media.

Fixed nozzle distribution is done by distributing a network of nozzles above the surface of the media in such a way that the spray pattern will evenly distribute the waste stream over the media's surface area.

Ventilation is very important so that aerobic conditions are maintained in the filter. This can be either by natural means or fans (forced ventilation). Natural ventilation occurs due to the difference in temperature between the air in the filter and that outside the filter. If the air temperature outside the filter is warmer than that inside the filter, the movement of air is from top to bottom. If the outside air temperature is colder than the air inside the filter, then the movement of air is from bottom to top. If these temperatures become equal stagnation occurs, and there is little or no movement of air. Forced ventilation uses fans or blowers to force air through the filter media, ensuring that enough oxygen is supplied to the biomass so septic conditions cannot occur.

The secondary clarifier is an important part of the trickling filter process. The clarifier can be circular or rectangular. The sloughed biomass from the trickling filter settles out in the secondary clarifier. The solids should be pumped from the clarifier regularly so a buildup of solids and/or septic conditions does not occur. Pumping solids should be done more frequently with warmer temperatures or higher organic loadings.

OPERATIONAL MODES

The mode of operation in which the trickling filter process operates depends on the organic loading and hydraulic loading applied to the filter. The operator has little or no control over the organic loading, unless recirculation is available, which can dilute influent wastewater. In some designs, the hydraulic loading rate can also be controlled.

Standard Rate Filters

The hydraulic loading rate for a standard rate filter ranges from 25 to 100 gal/day/ft^2 (1.1 to 4.4 mgd/acre). The organic loading rate ranges from 5 to 23 lbs BOD/day/1,000 ft^3 (220 to 1,000 lbs BOD/day/ac ft). The media usually ranges from 6 to 10 feet in depth. Standard rate filters do not recycle; the wastewater goes through the trickling filter only once.

High Rate Filters

High rate filters recirculate the flow over the filter so the waste stream makes more than one pass over the media. The hydraulic loading rate ranges from 200 to 1,000 gal/day/ft^2 (8.7-44 mgd/acre) and the organic loading rate ranges from 23 to 115 lbs BOD/day/1,000 ft^3 (1,000 to 1,500 lbs/day/ac ft). The media usually ranges from 3 to 8 feet in depth. With the higher hydraulic loadings, sloughing occurs on a continuous basis.

Roughing Filters

Roughing filters are used to reduce the organic loading to the treatment processes that follow it. These filters are loaded heavily because high effluent quality is not required. Any filter that operates under an organic loading greater than 115 lbs BOD/day/1,000 ft^3 can be considered a roughing filter.

Filter Staging

Effluents of higher quality can be obtained by a two-stage filter system. Staging is when two filters are placed in series. A secondary clarifier may or may not be between the two filters. Two-stage filter systems usually have recirculation capability.

TRICKLING FILTER MICROBIOLOGY

Biomass

Biomass grows on the surface of the filter media. Filter biomass consists of aerobic, anaerobic and facultative organisms, such as bacteria; protozoans; and fungi. Sludge worms, filter fly larvae, snails, rotifers, and other higher animals frequently find the environment suitable for growth. The surface of the bed may support algae when sunlight and temperature conditions are suitable.

Nutritional Requirements

The nutritional requirements of the biomass, in most cases, include carbon from both soluble and insoluble organic matter (BOD) as well as nitrogen and phosphorus. The ratio of carbon source to nitrogen source BOD/N is 20/1. The ratio of carbon to phosphorus source BOD/P is 100/1. For most municipal wastes the actual BOD/N ratio is much less than 20/1; therefore, the growth limiting factor is usually the carbon source (BOD). For industrial wastes, however, it may be necessary to add sufficient nitrogen (as ammonium ion NH_4^+) and phosphorus (PO_4-P) so that they are in sufficient quantity to satisfy the nutrient needs of the biomass. As the organic matter is metabolized, about 60 percent goes into the growth of biomass (sludge), while the remaining 40 percent is used in the respiration. The final products are carbon dioxide (CO_2), water (H_2O), and cell tissue.

Rate of Metabolism

Organic matter not only supplies the carbon source, but is also an energy source, since it can be oxidized in the presence of oxygen. The process of using the organic matter as both a food and energy source is termed metabolism. The rate of metabolism is limited by either the available organic matter (BOD) or by the available oxygen. At low organic concentrations, the organic matter controls the rate of metabolism. As the organic concentration increases, the rate of metabolism is more dependent on the available oxygen. Most filter loadings are such that the rate of metabolism is not limited by the rate of oxygen transfer, but by the organic matter available. Temperature has a large effect on the rate of metabolism.

Rising temperatures increase metabolism. A basic rule that can be used is that the growth race will double for every 10½° C rise in temperature. Microbial activity in the filter is a function of the waste stream temperature. Temperature affects the temperature of the wastewater as explained under ventilation. Biomass activity and thus trickling filter treatment efficiency decreases when water temperature decreases.

Growth and Sloughing Cycle

The biomass grows as it feeds on the organic matter found in the waste stream. The thickness of the biomass can become great enough to limit oxygen and nutrient diffusion to the innermost layers. When this happens, anaerobic conditions develop close to the media while the outside layer is still aerobic. When the inner layer of hungry anaerobic microorganisms is no longer able to obtain nutrients by diffusion through the thick biomass, the inner layer dies and the biomass sloughs off the surface of the media. The growth cycle is then repeated. Sloughing is intermittent in standard rate filters but is continuous in high rate systems.

TRICKLING FILTER PROCESS MONITORING

Sampling and testing is done at a wastewater facility for two major reasons. One is to supply required data to the regulatory agencies. The other is to monitor the plant processes, so the most efficient treatment can be accomplished in the most economic manner. This text will discuss the use of lab data to aid in plant operations.

Biochemical Oxygen Demand (BOD)

Since treatment of wastewater with trickling filters is primarily a biochemical oxidation process, the 5-day, 20$\frac{1}{2}^{o}$ C BOD determination is the principal measurement used to assess both the strength of the applied wastewater and the quality of the settled trickling filter effluent. It is used in conjunction with the flow to calculate the organic loading applied to the filter and the efficiency of the filter or of the filter and subsequent secondary clarification. When the 5-day test is used the values are reported as mg/l BOD_5. Soluble BOD_5 can be determined by filtering the sample to be tested through a filter which removes the suspended solids. Soluble BOD_5 values give a good indication of trickling filter performance since particulate matter (SS) are primarily removed in the clarifier.

Suspended Solids (SS)

Suspended solids should be tested in the primary effluent and secondary effluent. From this data, the SS removal efficiency for the process may be monitored. When reductions in SS removal efficiency occur, there may be problems with the clarifier operation.

pH

Changes in waste stream pH can have detrimental effects on the microorganisms. Sudden pH changes could indicate industrial discharges to the system. The pH of the secondary effluent should be around 7.0. Lower pH's are possible if nitrification is occurring in the filter.

Dissolved Oxygen (DO)

Dissolved oxygen is required in the waste stream for the filter to operate properly. DO measurements from the primary effluent, filter effluent, and secondary effluent should be taken daily. A trend that shows lower than the weekly average DO is an indicator that more loading is being applied to the filter, solids are being retained too long in the clarifier, or the filter is not receiving the proper ventilation.

Temperature

The temperature of the wastewater has a significant effect on the growth rate of the biomass. Cold water temperatures cause slow growth rates, which will affect the quality of treatment. Because the trickling filter acts like a cooling tower, the waste stream can become very cold during the winter months causing reduced treatment efficiency.

The operator should take daily readings of the primary effluent and filter effluent temperatures and if possible take corrective action if cold temperatures are causing a treatment problem. See Operational Problems and Solutions section.

CALCULATIONS

The acquired lab data should be applied to plant operations. The use of acquired data to monitor plant performance is called process control. Following are calculations that are needed to analyze the acquired data.

Recirculation Ratio

The recirculation ratio is tne ratio of the recirculated flow over the filter to the average influent flow. This is determined by the following equation:

$$\text{Recirculation Ratio} = \frac{\text{Recirculated Flow}}{\text{Average Influent Flow}}$$

The equation shows that if a constant flow is pumped to the top of the filter, the recirculation ratio gets smaller as the raw sewage influent flow gets larger. Total flow over the filter in this equation and the following example includes the recirculated flow and the average influent flow.

Example: The treatment plant flow meter shows a flow of 1.5 mgd. The filter effluent is recirculated at a rate of 2.1 mgd. Total flow over the filter is 3.6 mgd. Find the recirculation ratio.

Recirculation ratio =

$$\frac{\text{Recirculated Flow}}{\text{Average Influent Flow}} = \frac{2.1}{1.5} = 1.4$$

Recirculation ratio = 1.4

Note: This ratio has no units.

Recirculation ratios usually range from 0.5 to 4.0. Increased recirculation in trickling filters may increase BOD removal efficiency.

Hydraulic Loading

The hydraulic loading on a trickling filter is a measure of the gallons of water that are applied to each square foot of the trickling filter each day. This is determined by the following equation:

$$\text{Hydraulic Loading} = \frac{\text{gpd Flow}}{\text{ft}^2 \text{ Area}}$$

The FLOW (gpd) in the hydraulic loading equation includes the RAW SEWAGE influent FLOW and the RECIRCULATED FLOW. This important parameter of trickling filter operation indicates the rate of flow over the filter surface area. As stated earlier, the hydraulic loading rates for a standard rate filter range from 25 to 100 gpd/ft^2 and the loadings for a high rate filter range from 200 to 1,000 gpd/ft^2. The hydraulic loading rate can be increased or lowered by increasing or lowering the recirculation ratio.

Example: The flow over the filter is 3.6 mgd. That includes the 1.5 mgd of raw sewage influent and 2.1 mgd of recirculated flow from the previous example. The filter has a surface area of 9,000 ft^2. Find the hydraulic loading.

$$\text{Hydraulic Loading} = \frac{\text{gpd Flow}}{\text{ft}^2 \text{ Area}}$$

$$= \frac{3.6 \text{ X } 1{,}000{,}000 \text{ gpd}}{9{,}000 \text{ ft}^2}$$

$$\text{Hydraulic Loading} = 400 \text{ gpd/ft}^2$$

Note: The units for hydraulic loading are gpd/ft^2.

Organic Loading

The organic loading to a filter is a measure of the pounds of BOD_5 that each cubic foot of media must treat each day. This is determined by the following equation:

$$\text{Organic Loading} = \frac{\text{lbs BOD}_5\text{/Day}}{\text{ft}^3 \text{ of Filter}}$$

This is an important indicator in filter operation, because organic loading rates affect the biomass growth rate, biomass thickness, and can be the major

factor leading to odor problems. Organic loading can be greatly affected by in-plant waste streams.

Example: The primary effluent BOD for a treatment plant is 2,160 lbs/day. The filter has a volume of 54,000 ft^3. Find the organic loading.

$$\text{Organic Loading} = \frac{\text{lbs BOD/Day}}{\text{Volume of Filter/1,000}}$$

$$= \frac{2,160 \text{ lbs/day}}{\frac{54,000 \text{ ft}^3}{1,000}}$$

$$\text{Organic Loading} = 40 \text{ lbs/1,000 ft}^3$$

Note: The units of organic loading are lbs/1,000 ft^3.

Process Efficiency

The efficiency of a process is given as a percentage. It is determined by the following equation:

$$\text{Efficiency} = \frac{\text{In} - \text{Out}}{\text{In}} \times 100$$

A properly operating trickling filter process with clarification should be able to obtain removals between 75 and 85 percent for BOD.

Example: The influent to a trickling filter plant contains 130 mg/l BOD_5. The effluent from the secondary clarifier contains 25 mg/l BOD. Find the removal efficiency.

$$\text{Efficiency} = \frac{\text{In} - \text{Out}}{\text{In}} \times 100$$

$$= \frac{130 - 25}{130} \times 100$$

$$\text{Efficiency} = 81\%$$

Secondary Clarifiers

The secondary clarifiers are an important part of the trickling filter process. Sludge pumping from the clarifiers should be carefully watched. This can easily be done with a depth probe, which allows the operator to monitor the depth of any accumulated sludge. The sludge should not be allowed to accumulate. Generally, the sludge is continuously drawn from the clarifier. In this way, the sludge is not allowed to become septic, float, or cause an unnecessary oxygen demand.

Process Indicator Trend Charts

Indicators of process efficiency are most easily analyzed visually. The best way to do this is to plot the data on a monthly trend chart. This gives the operator the ability to easily compare the factors that affect the process efficiency. With this knowledge and the knowledge of the capabilities of the equipment in the plant, the operator can make process changes to improve the efficiency.

The indicators that should be plotted are hydraulic loading, influent BOD_5, effluent soluble BOD_5, percent soluble BOD removal, and percent SS removal. The plots will show the relationships of the different indicators for each specific plant. The operators can use these indicators to improve treatment quality and trouble-shoot problem situations.

OPERATIONAL PROBLEMS AND SOLUTIONS

Even though trickling filters are easily maintained, operational problems can develop. The operator has options which can be taken to solve many of these problems. The following paragraphs introduce some common problems, and possible solutions to each of the problems.

Filter Flies

Filter flies can be a nuisance and a health hazard. They live and breed in an alternate wet and dry environment. Therefore, they are more common in low rate filters. Interfering with the fly life cycle can control the problem. The solution includes one or more of the following:

* Increase recirculation rate for short periods of time. The hydraulic loading must be greater than 200 gpd/ft^2 to flush filter fly larvae through the media. This should be done only if flow is available and channels and piping can handle the increased flow from a hydraulic standpoint.

* Keep the walls wet by tapping end gates or otherwise directing flow onto the walls. End gates are generally tapped with a 1/2- or 3/4- inch 45-degree bend which can be adjusted to discharge against the wall.

* Dose filter with approximately 1 mg/l chlorine for a few hours each week.

* On a routine basis, keep the distribution system free of obstructions to maintain uniform wetting of media.

* Apply insecticides to walls or other breeding areas if local regulations permit. Caution should be used when applying the insecticide and only insecticides approved for this use should be applied.

High Effluent Suspended Solids

High effluent suspended solids could be in violation of discharge permits. Check to see if:

* The clarifier is hydraulically overloaded. Reduce the recirculation rate.

* Denitrification is occurring in the clarifier. Observe if sludge is floating in clumps with small bubbles attached. Increase sludge withdrawal rate from the clarifier.

* Clarifier equipment is operating properly and the weirs are level. Repair or replace any broken equipment.

* There is a temperature gradient in the clarifier. Install baffles.

* Excessive sloughing from trickling filter is occurring. Determine if the sloughing is due to seasonal changes, high organic loadings, or toxic conditions.

* If there is a high organic load, increase clarifier sludge withdrawal rate and increase recirculation.

High Hydraulic Loading Rates

High influent flows can upset treatment efficiency. An equalization basin will minimize the effects. However, if the trickling filter plant does not have one, problems caused by high flows due to storm water flows can be controlled by the following:

* Reduce recirculation.

* Operate trickling filters in parallel if they are operating in series.

* Reduce in-plant, recycle streams.

Icing

Ice build-up can block movement of rotary distributor arms. Ice build-up on the filter media reduces the efficiency of the filter unit. In cold weather fine sprays freeze easily. To reduce ice problems on the filter media, air and wastewater temperatures should be controlled by:

* Reducing the amount of recirculation. Recirculated water has been cooled by the "cooling tower" effect. By reducing the number of times the water flows through the filter, the temperature of the wastewater can be controlled.

* Operating trickling filters in parallel, instead of series, to reduce the number of times wastewater is cooled.

* Partially opening end gates to allow water to flow rather than spray in a fine mist along the walls.

* Adjusting nozzles and splash plates for larger water droplets.

* Constructing wind screens or covers for wind protection.

* Breaking up and removing ice formations.

In-Plant Recycle Streams

All in-plant waste streams have the potential of causing high organic loadings. In-plant waste streams should be monitored and carefully released at appropriate times. Highly organic streams should be released at appropriate times to maintain uniform organic loadings on the trickling filters.

Low Temperature Wastewaters

Low temperature wastewaters result in decreased performance due to the decrease

in biomass activity. When air temperatures fall:

* Air circulation through the filters should be minimized by obstructing air vents or providing windbreaks.

* Same procedures used to alleviate icing problems can also be used.

Odors

Odors result when the treatment process goes anaerobic. Since trickling filters are designed to operate aerobically, corrective actions should be taken immediately.

* Check influent conditions. If highly organic loadings exist or H_2S is present, increase recirculation, prechlorinate, and/or add forced ventilation.

* Check filter vent pipes and filter drain for obstructions to circulation. Clear obstructions. If the underdrain system is flowing more than half full, reduce the hydraulic loading rate.

* Check for excessive biological growth. Increase recirculation rate to provide more oxygen and increase sloughing.

* Check filter and surroundings for slime growths and debris. Remove debris from media surface. Wash down splash plates, walls above the media, and surfaces exposed to wastewater splash. Prevent wastewater from splashing over filter walls.

Orifice Plugging

Plugged orifices result in nonuniform wastewater distribution over the surface of the media. The primary clarifier should be checked for inadequaciesin removing solids or grease which are causing the plugs. To unplug the orifices:

* Open end gates on the rotary arm and flush out the plug.

* If there is frequent plugging, install a screen ahead of the filter pumps or siphon.

Ponding

Ponding results from plugging of the filter voids. The voids may be plugged by excessive biological growth, caused by high organic loading, debris, insects, snails, improper media, or improper primary basin operation.

* Remove debris accumulated on the surface of the media.

* Agitate surface with a rake or high-pressure stream of water.

* Increase recirculation rate to flush filter.

* Let the filter or portions of the filter dry out for several hours or days to cause sloughing of excess growths upon re-wetting.

* Walk the filter. This is done by holding the rotary distribution arm and slowly walking it around the filter. Slowing the rotary arm causes a greater hydraulic loading to a small area of the filter, thereby sloughing excess growth or flushing out plugs.

* Flood the filter for about 24 hours. Release wastewater slowly.

* Dose the filter with chlorine at about 5 mg/l for several hours.

* Check primary treatment units and correct any malfunctions.

Reduction in BOD Removal

Effluent BOD is closely associated with SS. If both BOD and SS removal efficiencies drop, follow steps to correct high effluent SS. If only BOD reductions are falling noticeably, check for:

* Low temperature wastewater (see low temperature wastewater directions).
* Toxic loadings (see toxic loadings directions).
* High influent organic loadings. Increase recirculation ratio to increase the number of passes that the BOD will make through the filter.

Toxic Loadings

Toxic loadings can destroy the biological growth on the media and thus treatment efficiency. Usually, the toxic loading is not noticed until a day or two later when the biological process is not working and effluent BOD levels are high.

The best way to cope is to have strict industrial discharge limits. If an accidental spill does occur, the industry should pretreat.

References

Operation of Wastewater Treatment Plants, MOP II. WPCF, Washington, D.C.

Water Supply & Pollution Control 3rd ed., Clark, Viessman & Hammer, Harper & Row, New York, 1977.

Operation of Wastewater Treatment Plants, A Field Study Training Program, Kenneth D. Kerri, editor, California State University, Sacramento.

Worksheet

1. Calculate the surface area of a trickling filter with an 80-ft. diameter in ft^2.

2. Calculate the volume in ft^3 of a 150-ft. diameter filter that is 8 ft. deep in ft^3 and 1,000 ft^3.

3. If a trickling filter plant has an influent flow of 4.0 MGD and a total filter area of 25,000 ft^2, what is the hydraulic loading?

4. What is the organic loading in lbs BOD/day/1,000 ft^3 on a filter if there are 3,000 lbs/day BOD in the primary effluent and the filter has a volume of 72,000 ft^3?

5. If a plant influent flow meter reads 2.0 MGD and the recirculation flow is 3.0 MGD, what is the recirculation ratio?

6. If the primary effluent is 150 mg/l BOD and the secondary clarifier effluent is 25 mg/l BOD, what is the BOD removal efficiency for the filter?

7. Plant Data:

2 filters	- each 100 ft. diameter, 7 ft. deep
Total flow	- 2 MGD (equally split)
Total recirculation flow	- 1.2 MGD
Primary effluent	- 125 mg/l BOD
Secondary effluent	- 20 mg/l BOD

Calculate: Hydraulic loading
Organic loading
Recirculation ratio
BOD removal efficiency